The Sea-Serpent Explained

ON Monday, August 5, a number of geologists crossed in the Folkestone boat to Boulogne, to study the interesting formations of that neighbourhood, and, when about three or four miles from the French coast, one of these gentlemen suddenly exclaimed, "Look at that extraordinary object passing across the bow of the steamer, about a mile or a mile and a-half in advance of us!" On turning in this direction there was seen an immense serpent, apparently about a furlong in length, rushing furiously along at the rate of fifteen or twenty miles an hour; it was blackish in front and paler behind; its elongated body was fairly on the surface of the water, and it progressed with an undulating or quivering motion: *mirum erat spectaculum sane.*

Of course many suppositions were immediately started to account for this extraordinary phenomenon, but they quickly changed and settled into the fixed idea that the object before them could be nothing less than the great sea-serpent himself; for,—

> "Prone on the flood, extended long and large,
> Lay floating, many a rood, in bulk as huge
> As whom the fables name of monstrous size,
> Leviathan; which, God of all his works
> Created hugest, that swim the ocean stream."

The writer fortunately had with him one of Baker's best opera-glasses, and, after a few moments' use of this little instrument, the wonder was satisfactorily resolved. The first half of the monster was dark and glittering and the remainder of fainter hue, gradually fading towards the tail. The glass did not determine the matter until the extreme end was reached, and then it was seen to consist of a mass of birds in rapid motion; those that were strong on the wing were able to keep well up with the leaders, and so make the head appear thicker and darker by their numbers, whilst those that had not such power of flight were compelled to settle into places nearer and nearer the tail. Doubtless these birds were shags (*Pelicanus cristatus*) returning to their homes for the night from the distant waters in which they had been fishing, during the day; perchance it may be wrong to assert positively as to the variety of bird, but inasmuch as the writer has often seen shags on the Cornish coast in smaller numbers returning in single or double file to their roosting places, and since it is stated in works of natural history that they have been noticed occasionally flying in this peculiar manner to the number of a thousand or more, it does not appear an unwarranted liberty in supposing that they really were *Pelicani cristati.*

It is to be feared some of the geological gentlemen still doubt the interpretation of the lorgnette, preferring the fond deceit of a large and unknown serpent; but as in this case individual birds (scores of them) were distinctly seen flapping their wings, the writer has thought it his duty to report the circumstance to you that your readers who voyage across the seas may keep their opera-glasses in their pockets and verify for themselves, on the first opportunity, this interpretation of the great sea-serpent. JOSEPH DREW

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Parental Affection in Sparrows

I SAW a touching little incident showing the affection of sparrows for their young on the Kennington Oval cricket-ground last Thursday afternoon, a description of which you may, perhaps, think it worth while to record.

The afternoon was fine and the ground was surrounded by a dense ring of spectators, when a young pale-coloured sparrow, under the guidance of both its parents, was trying to acquire the use of its wings. A slight wind was blowing towards the spectators, and the poor little bird, in its weak attempt to fly, was, to the evident consternation of its parents, carried straight into the laps of the inner ring of spectators, one of whom caught it gently in his hand and held it.

When taken hold of the young bird gave two or three chirps or calls for help, and the old birds flew to within a few feet of the ring of spectators, and, alighting on the grass in front of them all, began to "beg" for the young bird in the most touching and beseeching manner. This they did by lowering their heads and making the peculiar flutter of the wings by which young birds beg for food from the old ones. This singularly touching appeal moved the hearts of many in the crowd, who called out—"Look! look at the old birds!"—"Don't hurt the young bird!"—"Give it back to them," &c. The anxiety and the boldness of the old birds and their humble beseeching for the young was so evident as to come home to the hearts of these somewhat rough spectators.

My own feeling certainly was that I could not have believed that a pair of sparrows could possibly have "begged" with such touching humility and tenderness for the safety of the young bird. Their manner clearly displayed their sense of their own want of power to help the object of their affection, they therefore prayed for mercy in their own way, and with so much feeling, as to excite the full sympathy of the crowd looking on, and to make them, for the time, forget the game of cricket they had come there to see. C. R.

Bristol, August 17

PHYSICS IN PHOTOGRAPHY

IN taking a retrospective glance at the remarkable phenomena exhibited in photography, an endeavour will be made to explain them as far as possible by the light that may be thrown upon them by modern research, and at the same time to suggest extensions which probably may be given to this branch of science by further investigations. We may perhaps be open to rebuke from some for venturing to call photography a science; but surely as long as there are problems in it to be solved which require direct scientific solution, and which perhaps indirectly lead to the research in other directions, so long, at least, must it be something beyond a mere industrial pursuit. It is not the fashion to deny to electricity the honourable distinction of being a science, although it has become an industry in its application to telegraphy; why, therefore, it should be considered correct to consider the study of the chemical action of light upon compounds as something to be remitted to the intellect of those who are merely interested in it commercially, it is difficult to understand. It would surely be much better that men of science who employ photography in their laboratories and observatories, should endeavour to understand the science of attack with the weapon they are using, instead of regarding it as a simply mechanical agency, which is only worthy of the attention of, perhaps, a half-educated assistant. If our men of science who employ both were to be as ignorant of the principles of electricity as they too often are of those of photography, research would be very much restricted in its results; and it may, it is believed, be said with truth that a familiarity with even the first principles of photography would very much extend it. We may remark, by the way, that to instil a love of science into youth, an education in photography would seem to be of great value, as experiments can be made which have a real meaning to the experimenter, and which, by allowing an almost endless variation, offer an unlimited field for the exercise of the reasoning faculties. A study of photography, in short, must encourage the study of chemical and physical sciences, if a distinction may be made between the two.

Photography must undoubtedly be divided into two distinct branches: the direct production of the visible image by light itself, and the development of the invisible image by chemical means. The recognition of the former we owe to Wedgwood, and of the latter to Daguerre. The discovery of the former is much less remarkable than of the latter, since, without any particular research, a discoloration of a compound by light must have been noticed, whereas the development of an invisible image would have been a matter of theoretical reasoning, unless accident showed its feasibility. We know that the development of Daguerrean images was discovered accidentally by Daguerre, and we also know that the development of the image on paper was discovered accidentally by Reade. Without two such wonderful strokes of good fortune the growth of photography might have been retarded for years. The years which succeeded the discovery of the developable image were productive of research into many of the phenomena exhibited by the action of light on sensitive compounds, and, owing to the great intellects

who gave their attention to it, many important problems in photography were solved. Succeeding these years, however, were others in which little was done in the absolute science of the subject, though great progress was made in perfecting the processes which had been brought forward. Within the last few years a fresh start in research in all directions seems to have been made, and much that is valuable in elucidating the correct theories on which photography is based has been demonstrated, and it is to this to which attention will be drawn.

With the risk of being tedious, ground which has been well trodden must once again be briefly gone over, in order to estimate the progress which more recently has been made. Scheele, the Swedish chemist, as is well known, found that the blackening of silver chloride (which was the basis of Talbot's pictures) gave up chlorine on exposure to light, thus proving, as it were, that the blackening was due to the formation of a new chemical compound. As far as can be traced not much more was known regarding this compound; but it was a generally-received notion that it was a subchloride of silver; and up to the present time we find that such is the accepted opinion. In the second edition of Hunt's "Researches on Light," published in 1854, at p. 79, a remarkable experiment is noted. He says:—"The exposure (of silver chloride) in the water was, in another case, continued for several days, but no greater degree of darkening occurred; but a curious fact was noticed. It was found that during the night nearly all the chlorine which had been liberated during the day was recombined, and that the darkened powder became lighter" . . . . He then, after recounting other experiments, says (p. 123):—"From other experiments I am inclined to believe that the first action of the solar ray is to liberate one half of the combined chlorine, which is very readily, moisture being present, replaced by oxygen. By the continued action of the exciting cause the oxide is decomposed, and metallic silver in a fine state of division, is formed over the surface" (of the paper).

P. 125:—"The absorption of oxygen, or rather its combination, with the decomposing chloride is proved by another very easy experiment. Some pure chloride of silver was arranged in a bent tube closed at one end, and the other end immersed in a bottle of distilled water. In this state the chloride was exposed for many days to the action of sunshine, during which time it was frequently shaken for the purpose of exposing the whole of the powder and its influence. As the chloride darkened, the water rose in the tube, and it gave a precipitate of chloride of silver on the addition of the nitrate, thus appearing to prove the substitution of oxygen for chlorine under the agency of solar radiation. It was quite evident that some absorption of atmospheric air had taken place. This explanation will also serve for the iodide, bromide, and some other salts of this metal (silver)."

This last experiment has lain fallow for years, and it is only recently that it has had any meaning beyond that indicated in the quoted paragraph. It must be borne in mind, however, that the visible change in the chloride is here under consideration, and that the invisible effect of light was not mentioned.

With regard to the developable and invisible image, till within the last few years, it was a debatable point as to whether the action of light on a sensitive compound was really a chemical change, or simply a physical action; one school held that the sensitive compound was not altered in composition at all, but that in some mysterious manner the atoms of the molecules composing it were shifted, and possessed a new property which was denied to it in its original form. Diagrams were introduced to render this subtle change clear to the student, one of which is reproduced (Fig. 1).

In A we see two ovals slightly differing in size, each of which was intended to indicate one of the atoms composing a molecule of the sensitive salt. When the ovals coincided, the molecule was supposed to be in the ordinary state, but after light acted upon it for a certain time the ovals occupied the positions shown in B, and after a further action of light they occupied the positions shown at C, in which it again became incapable of proper development, and gave rise to what was known as *solarisation*, the part of the "*latent image*" formed by these solarised molecules refusing to *develop*. By solarisation was meant the phenomenon which occurred (more especially if silver films containing iodide were used), when any portion of the plate received a lengthened exposure to any very bright part of the lenticular image, such as to that of the sky. In solarisation we have have a term which is as unmeaning as is "polarisation" in some of its applications, but since it has passed into the technical language of photography, we are bound to employ it. By the term latent image was meant the invisible (and usually) developable image impressed upon a sensitive film, and it will be used, where convenient, with the reservation once for all, that its applicability is not admitted any more than is the term "developer," as applied to a solution which may cause the deposition of metallic silver from a solution of silver nitrate; since such a solution is effective whether applied to an exposed sensitive film or not. The advance of photography has literally been impeded from the neglect of using accurate language. As regards this peculiar condition which the molecule was supposed to have attained after its impact with light, there seems to be no ground for its adoption. The idea seemingly arose from a supposed necessity which existed for a difference in condition between the visible and the

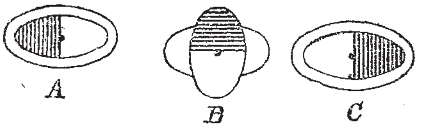

Fig. 1.

merely developable image. By a strictly logical inference there need be no difference between the two beyond this that there should be a difference in the number of molecules absolutely altered, and in no other respect. Perhaps the most telling experiment giving *direct* evidence of the similarity of the two images was that made by Poitevin, in which he proved the dissociation of iodine from silver iodide, by placing metallic silver in contact with the film. After exposure to light, on separating the two, he found that the latter had absorbed iodine, as proved by treating it with mercury vapour. The *circumstantial* evidence of the truth of the chemical theory of the invisible image, however, is so strong, that on that alone we are bound to accept it, at the same time we are not prepared to say that there are not other physical forces which must play a part in its development; in fact, it must be so. We may say, then, that at its *first formation* the developable photographic image is formed by the reduction of the sensitive compound to one of a less complex nature. Thus, silver chloride (argentic chloride) is reduced to silver sub-chloride (argentous chloride) with the liberation of chlorine; and silver bromide to silver sub-bromide with the liberation of bromine; and so on.

We must now allude to the development of the photographic image. We may divide the methods of development of the image on silver compounds into three: (1) The condensation of mercury; (2) the deposit of metallic silver from a soluble salt of silver by means of a reducing agent such as ferrous sulphate; and (3) the reduction of the sensitive salt of silver itself to form the image.

The first method is the earliest, dating from the discovery of the Daguerrotype process, and till within very recent times the reason of its efficacy has been a subject of controversy. Quincké has lately thrown a light upon

it in one of his memoirs, and his explanation seems to account for it in a most perfect and philosophical manner.

In the Daguerrotype process, it will be remembered, a silvered plate is subjected to the vapour of iodine (or of iodine and bromine), and thus receives a fine layer of a compound which is sensitive to light. When a plate so prepared is exposed to a lenticular image in the camera, the light causes the iodide (or bromoiodide) of silver to throw off iodine (or this together with bromine), which is immediately seized by the silver beneath, and thus forms a deeper layer of the sensitive salt. The depth, almost immeasurable though it be, depends on the intensity of, and length of exposure to, the light. (That this is the case has been proved by the fact that, if the sensitive layer be removed by a suitable solvent, the surface beneath is shown by reflected light to be etched to a greater or less degree.) The invisible image thus formed is exposed to mercury vapour, and the dew condenses on it proportionately to the depth of the layer. Quincké, in his memoir "On the Edge Angle and Spread of Liquids on Solid Bodies,"[1] shows that the edge angle of a drop of liquid on a solid body varies from zero to a constant quantity, according to the thickness of any fine layer of impurity which may be on the latter. When this layer attains a certain value then the edge angle of the drop will remain constant. The thickness, or rather the thinness, of the layer may be appreciated when it is stated that it bears a relation to what is called "the radius of the sphere of sensible action of molecular forces," and is usually greater than ·00005 millimetre. In this case the sensitive plate is the solid body and the invisible image forms different thicknesses of impurity. By this difference in the edge angles of the mercury dew, condensed on different portions of the latent image, the light is reflected in different ways, which gives rise to the visible image.

This explanation entirely does away with the necessity, which previously seemed to exist, of the silver iodide (or bromo-iodide) being reduced to the metallic state, in order to cause condensation, or—perhaps it might be said—to cause the formation of an amalgam of mercury and silver.

The next method of development speaks for itself; the metallic silver is deposited in fine granules and is attracted by the salt which has been altered by the influence of light. Perhaps further investigation will show that development is dependent on what is known as the Brownian movement, or the rapid movement of small suspended particles in a liquid. If this movement be dependent on the electrical condition of the neighbouring body, as has lately been supposed; and if, as Dewar has shown, the condition of an exposed sensitive salt is electrical, then the deposition of the metallic particles of silver on the image is accounted for in a satisfactory manner.

The last mode of development is principally employed with silver bromide, and is known as the alkaline method. When a film of collodion or gelatine holds a sensitive salt on a plate, the portions exposed to light are reduced to the metallic state by the application of an oxygen absorbent such as alkaline pyrogallic acid. Since the image is invisible, it must be remembered that but a few molecules of the sensitive salt are reduced by the action of light to the less complex and developable form, we therefore must look for some further action between the developer and the rest of the unaltered compound. It has lately been proved that silver bromide or silver chloride cannot exist in *close* contact with metallic silver. It invariably forms the developable salt. Thus if we take a glass plate, silvered by any of the well-known processes, and expose it to the fumes of bromine or to hypobromous anhydride, it will be found that it is impossible to secure a film of argentic bromide until the last trace of silver has been attacked, after which the true colour of argentous bromide gradually gives way to the well-known colour of argentic bromide. We may try the experiment with bromine water and the same holds good. The action of chlorine on silver is the same as of bromine, but the action of iodine seems to be different, the fully saturated compound, argentic iodide, being formed at first. In other words, this compound is the more stable than argentous iodide.

[1] *Phil Mag.*, May and June, 1878.

Now the alkaline developer, when mixed with a soluble bromide of an alkali, has the property of much more readily attacking the argentous than the argentic bromide, presumably because the soluble bromide used in development combines with the former, giving rise to an apparently difficultly reducible compound, whilst it refuses to combine with the argentous salt. It is thus easy to see, if this property of the developing solution be connected with what was stated in the preceding paragraphs, how development takes place. The developer is applied to the exposed film, and the minute quantity of argentous compound is reduced to the metallic state, and at once this particle of silver which is in close contact with the unaltered compound combines with it and forms new argentous bromide. This is ready for attack by the developer, and thus the action spreads till the whole thickness of the sensitive salt is reduced to the metallic state where the greatest exposure has taken place. An interesting result[1] of this action is afforded by the fact that, if a film of unexposed argentic bromide be superposed over one that has been exposed, the image impressed on the latter can be developed in the former so long as close contact is secured. It has been said that this action is due to the solubility of the silver-bromide used in the alkaline development; and, to some extent, this is true; but it is evident that this cannot be explanatory of the whole phenomenon, since the same effect is produced by using, with the pyrogallic acid, potash as the alkali in which the silver-bromide is absolutely insoluble. We have been thus particular in showing the cause of this alkaline development, as it explains some phenomena to which attention will subsequently be called, and which otherwise would be inexplicable, except by reversing usually-accepted physical laws.

W. DE WIVELESLIE ABNEY

(*To be continued.*)

MILITARY BALLOONING

THE matter of ballooning for military purposes appears to be once more attracting attention in this country. In France they have now a properly organised service under the command of a colonel of the National Engineers, who considers all novelties and proposals as they arise, and who sees, moreover, that the State has always a body of skilled aëronauts at its disposal. At the end of the Paris siege the Postal department, it may be remembered, possessed a large number of balloons, and these being handed over to the French war minister, constituted the *matériel* necessary in the formation of a military balloon service. Col. Laussedat, whose name as an energetic officer of the French Topographical Department, is well known, was placed in command, and he at once secured the services of one of the Messrs. Goddard to put the whole of the apparatus in a fit condition for service. Since that day ballooning in France has been considered as much a duty of the Engineers of the army as telegraphing and surveying, and classes both for officers and men are held for instruction. Lately, by the resignation of Col. Laussedat, the French balloon service has lost its chief support; but his place has just been supplied by Gen. Farr, who will, no doubt, take measures to maintain the high efficiency which has been attained by his predecessor.

In France, as in this country, the balloon is chiefly

[1] *Phil. Mag.*, January, 1877.